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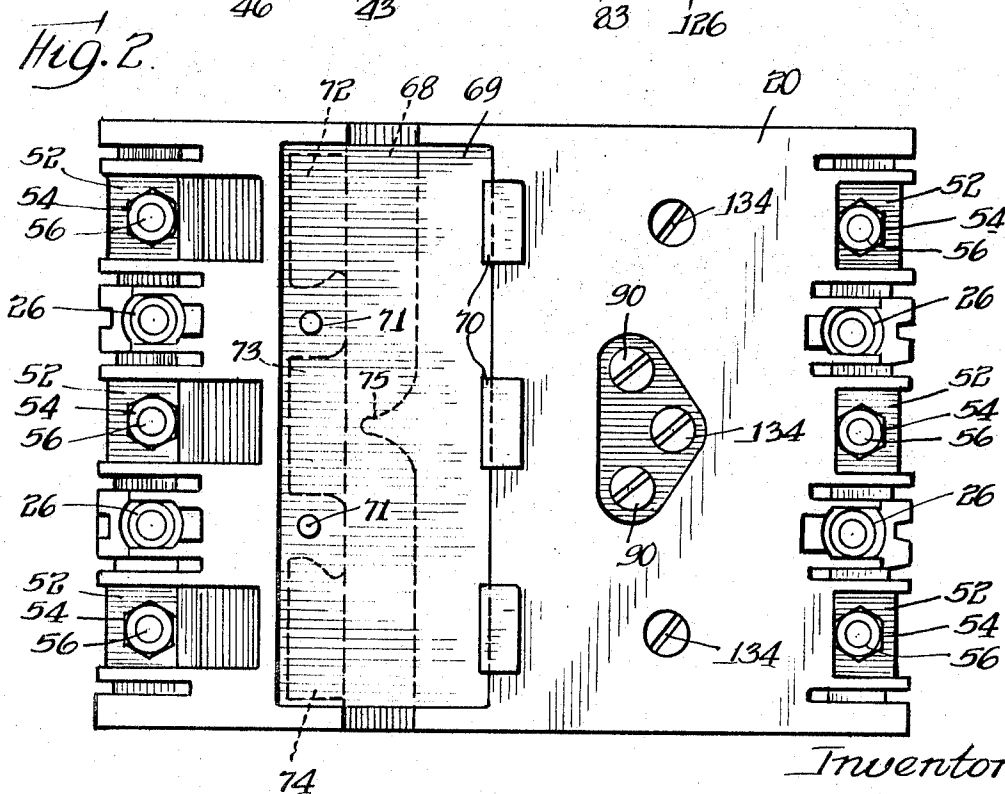
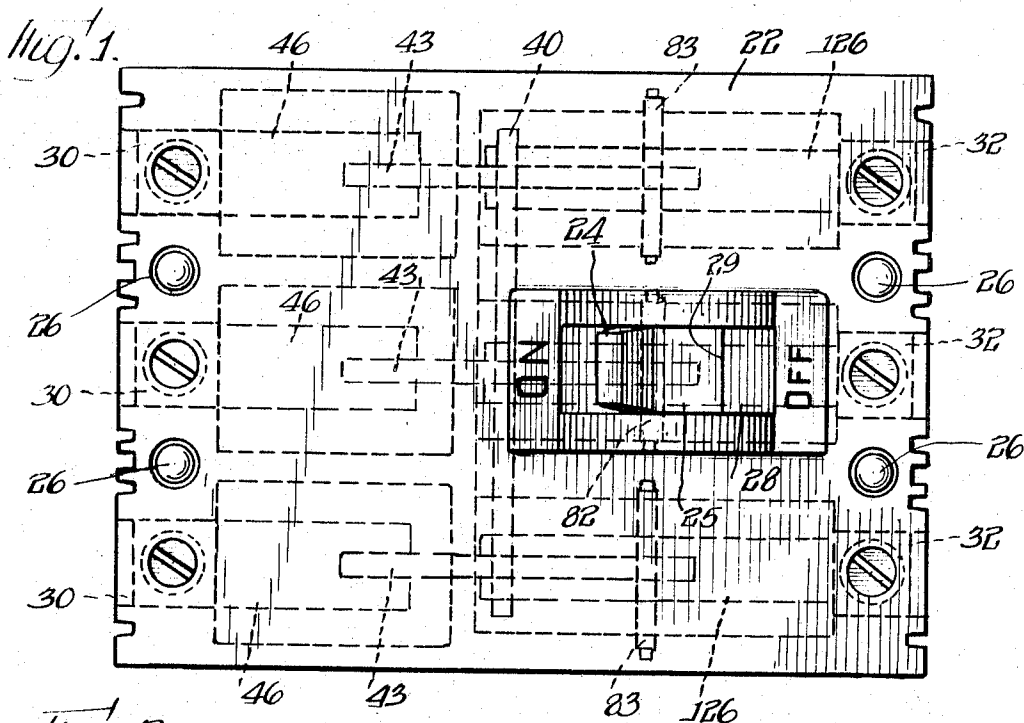
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3,341,791

ELECTRIC CIRCUIT BREAKER WITH IMPROVED OPERATING MECHANISM

Filed June 16, 1964

8 Sheets-Sheet 1



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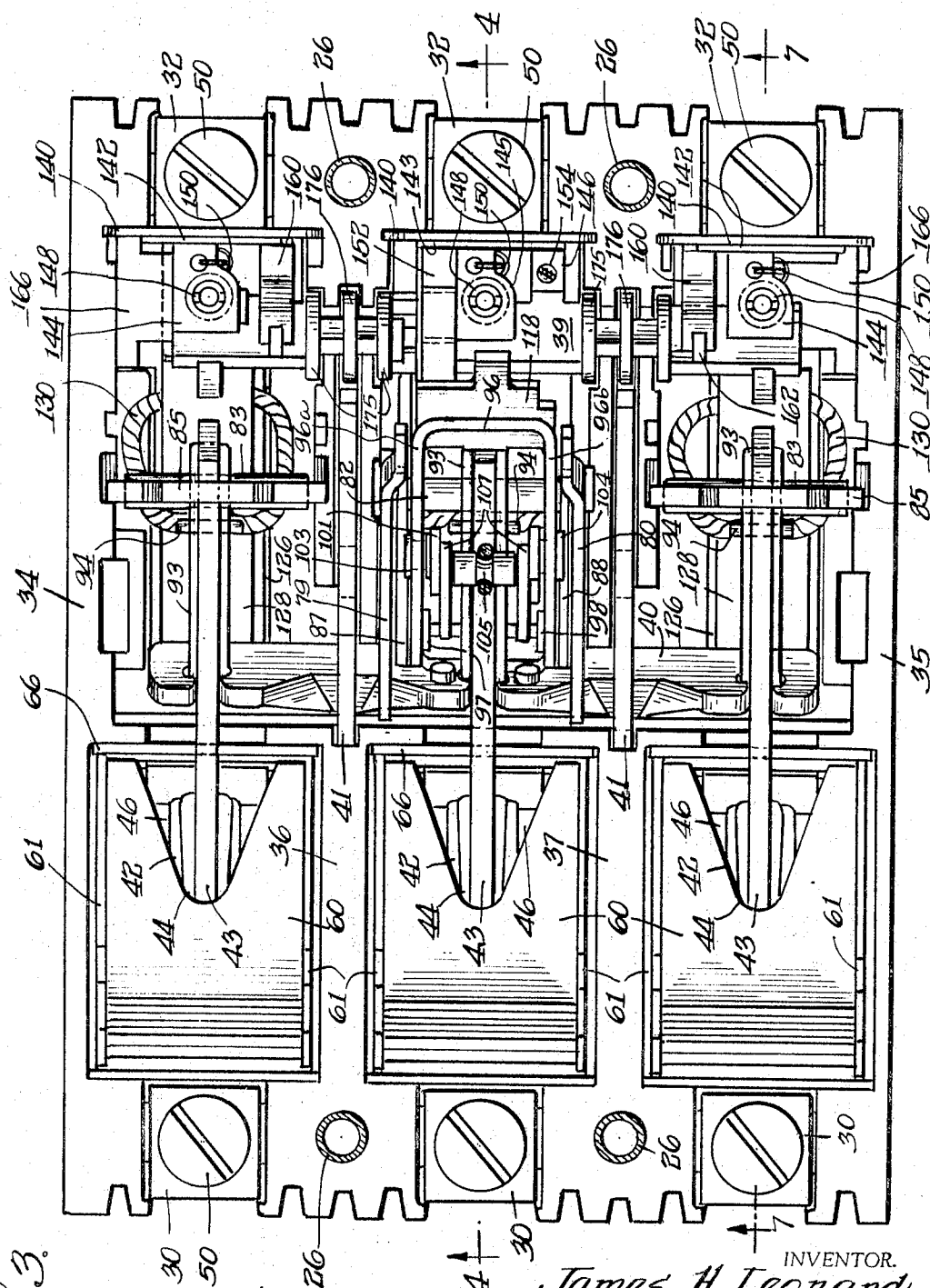
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ELECTRIC CIRCUIT BREAKER WITH IMPROVED OPERATING MECHANISM

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8 Sheets-Sheet 2



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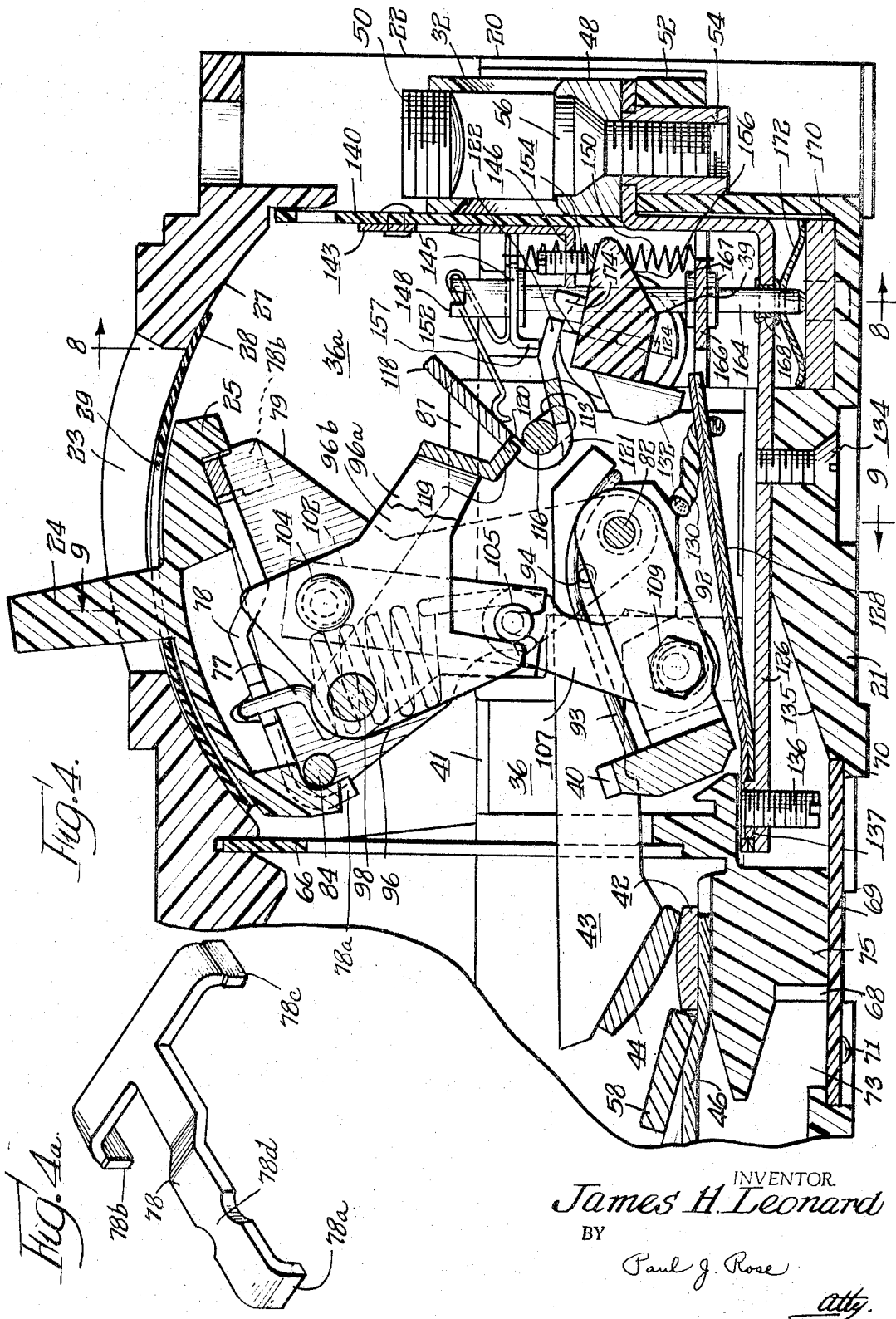
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ELECTRIC CIRCUIT BREAKER WITH IMPROVED OPERATING MECHANISM

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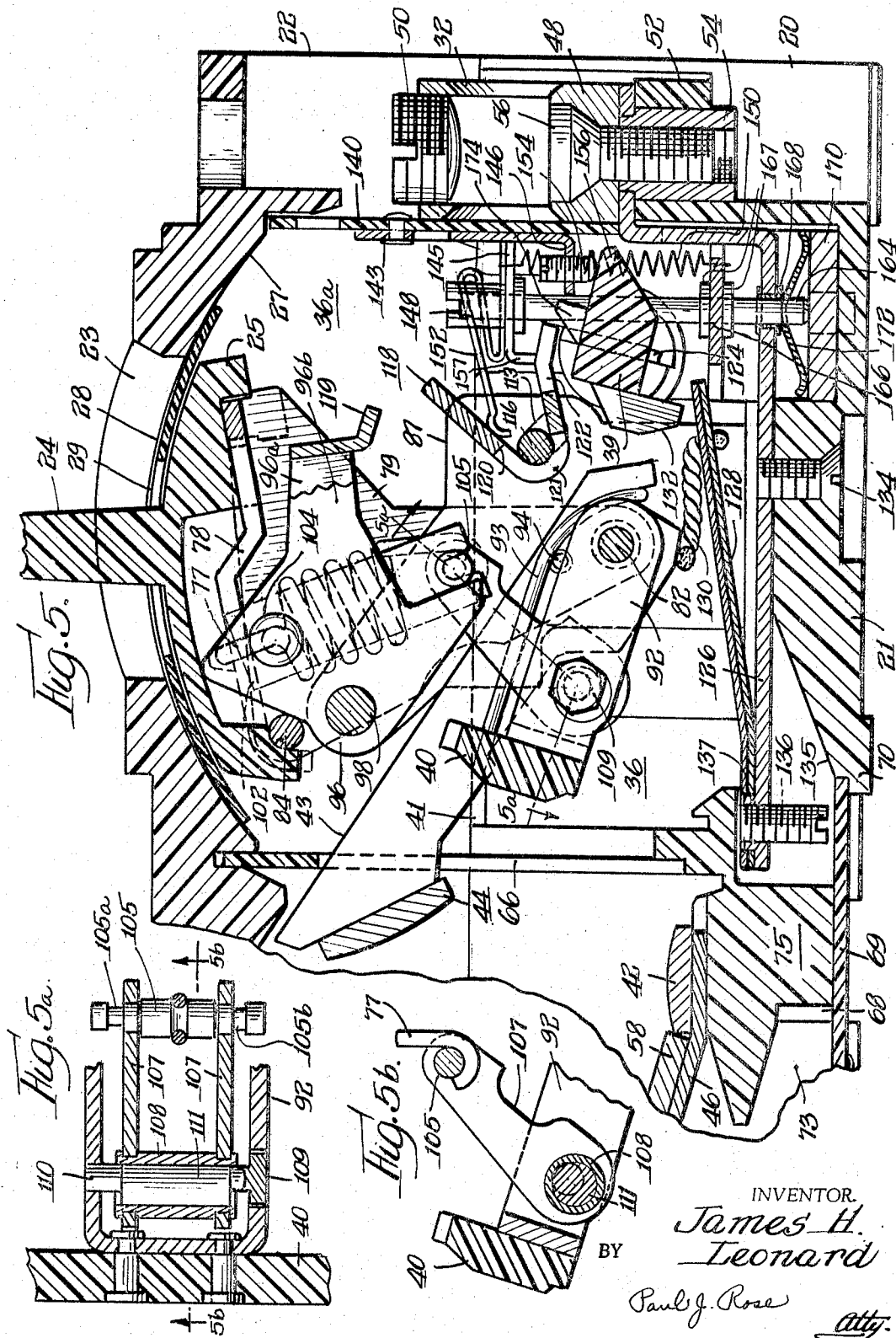
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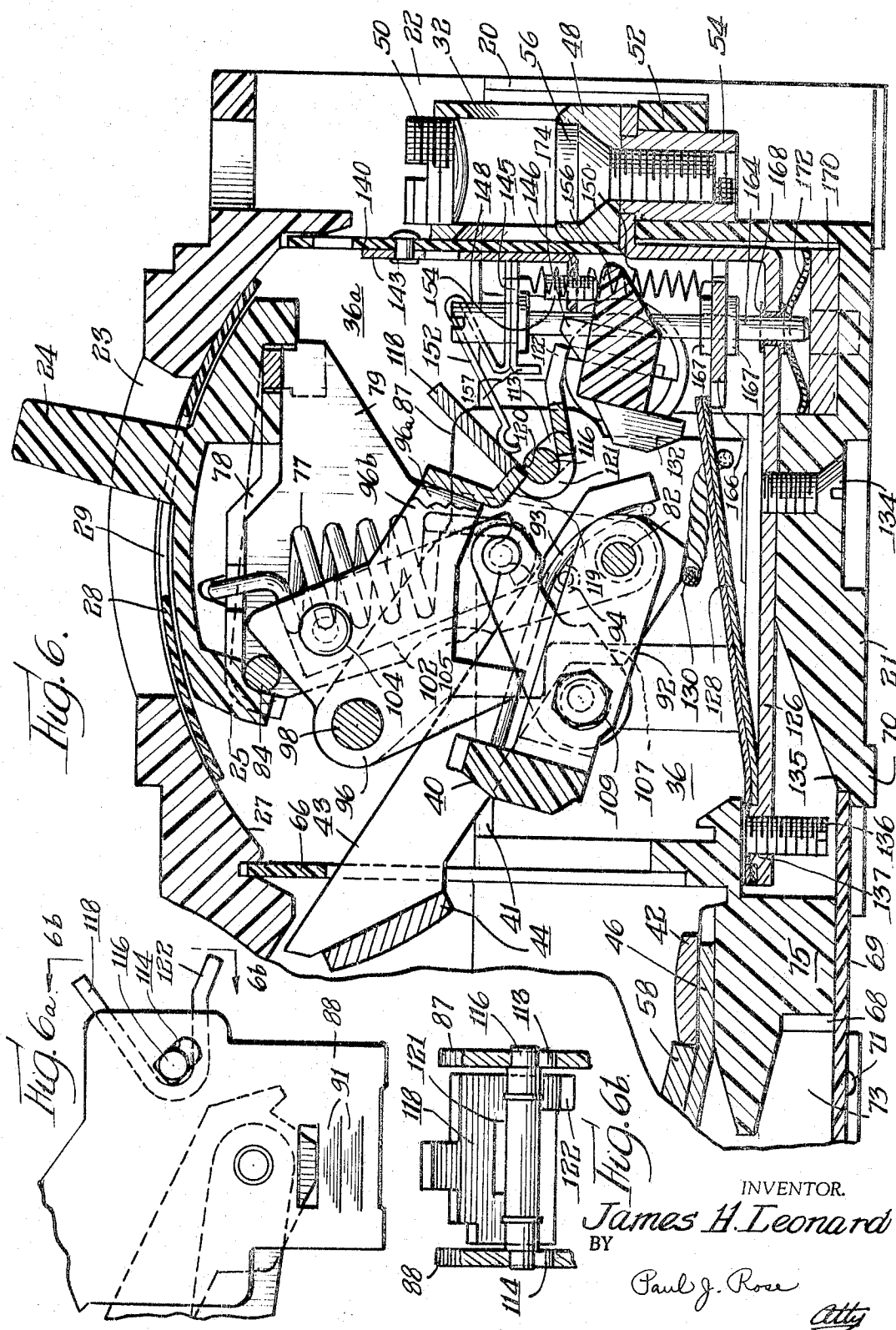
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ELECTRIC CIRCUIT BREAKER WITH IMPROVED OPERATING MECHANISM

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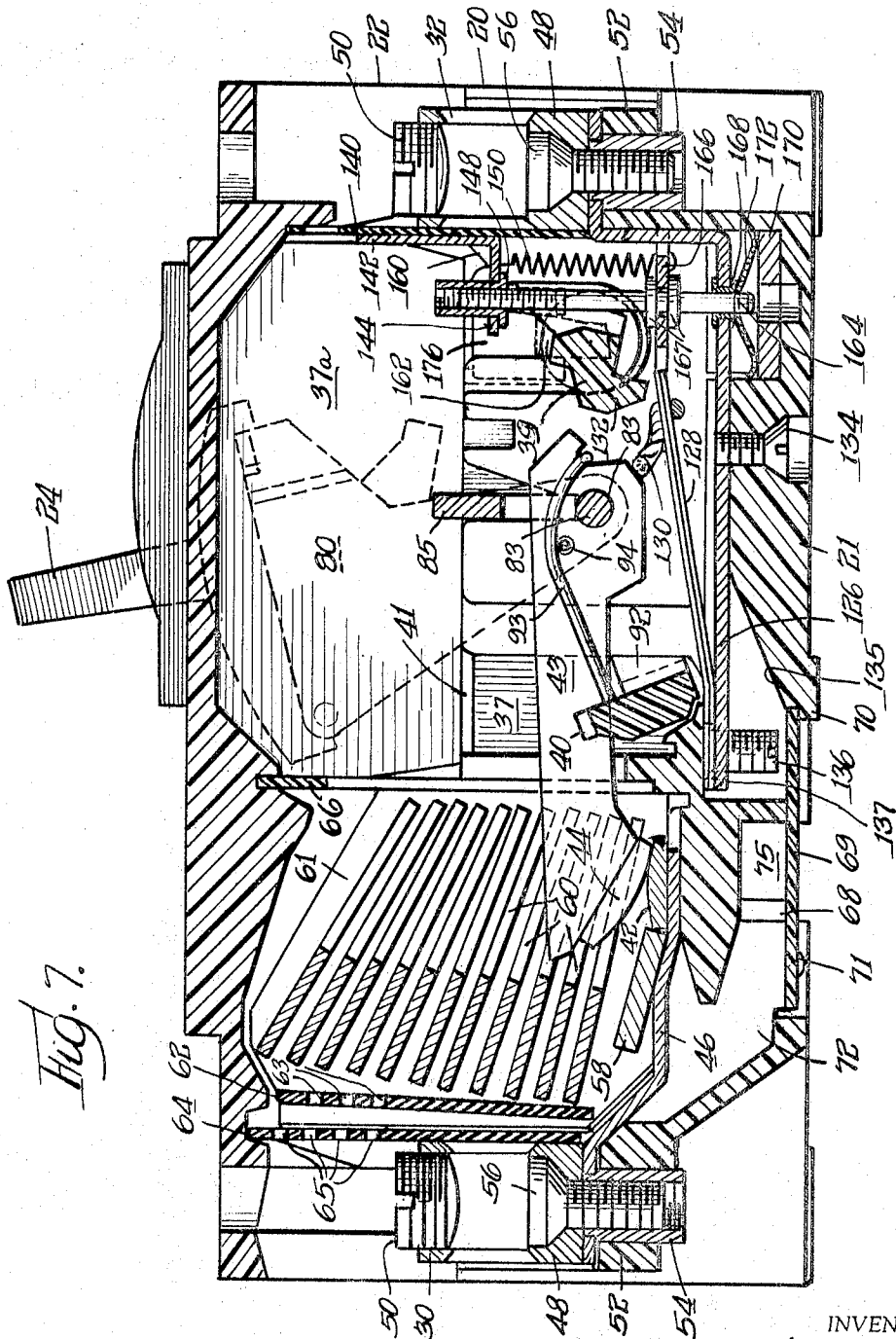


Fig. 7.

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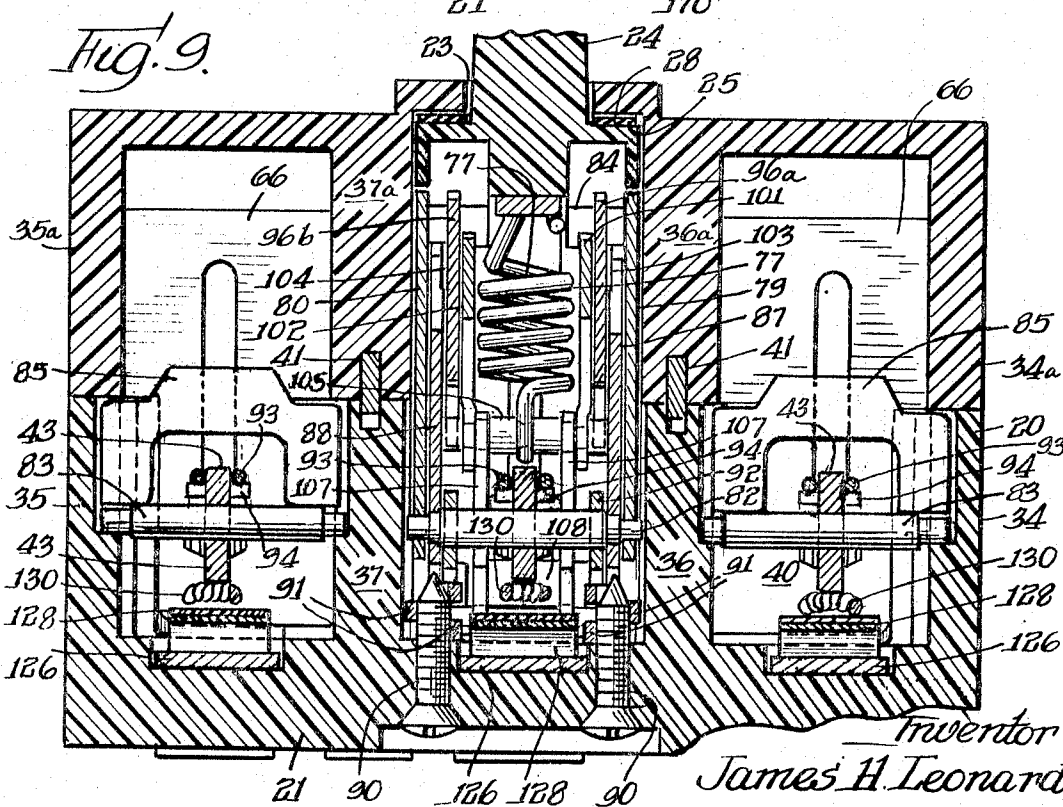
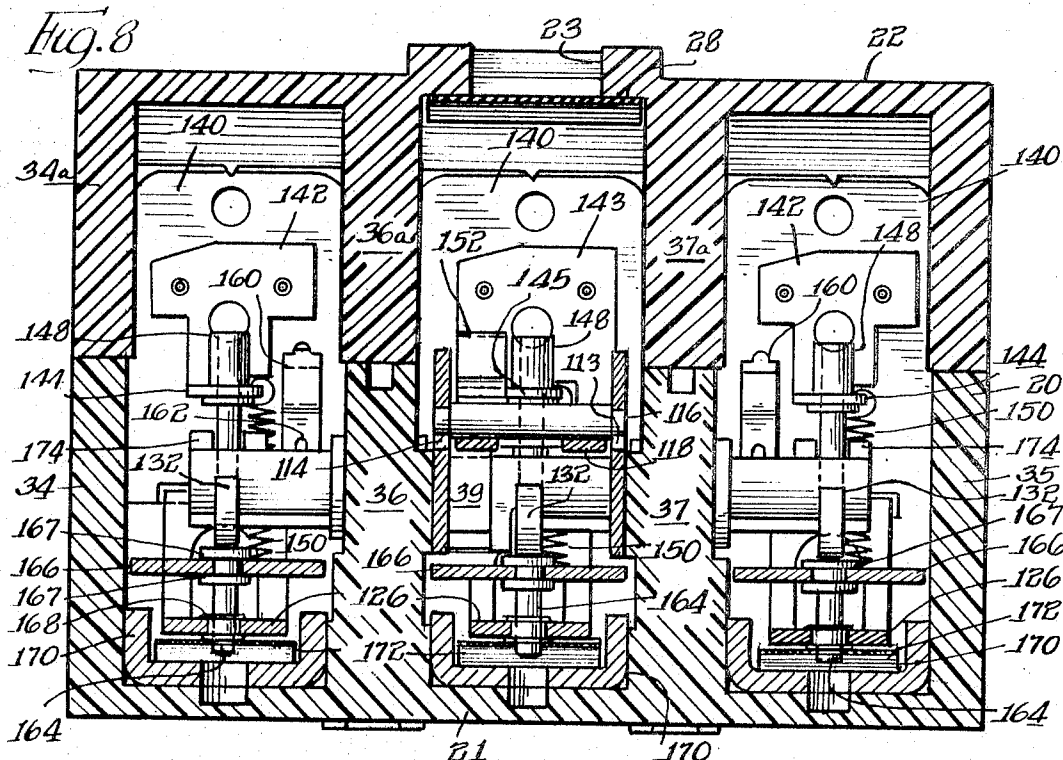
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ELECTRIC CIRCUIT BREAKER WITH IMPROVED OPERATING MECHANISM

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Fig. 10.

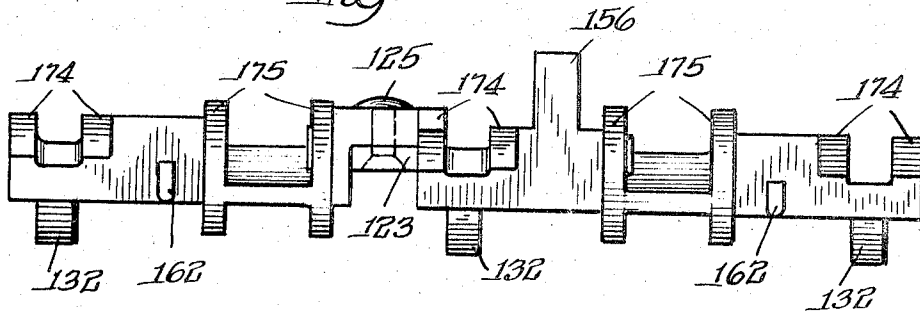


Fig. 11.

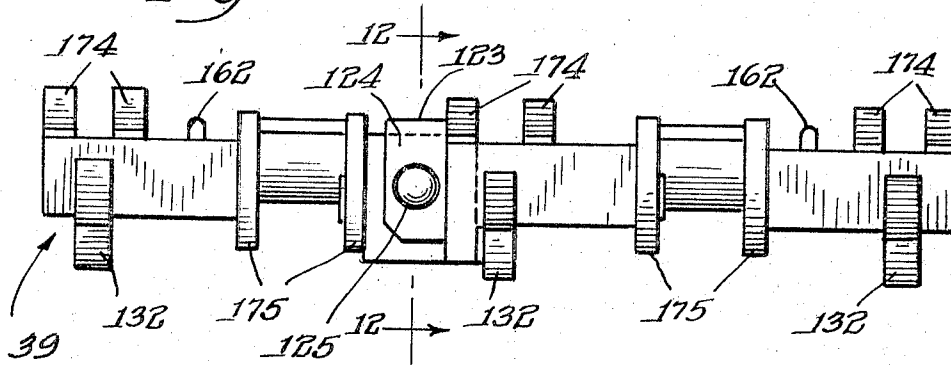
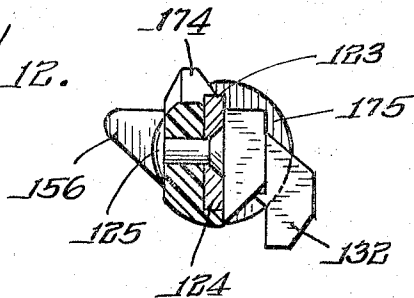


Fig. 12.



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ELECTRIC CIRCUIT BREAKER WITH IMPROVED OPERATING MECHANISM

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14 Claims. (Cl. 335-35)

This invention relates to electric circuit breakers and is more particularly directed to circuit breakers of the type including magnetically responsive means for tripping the circuit breaker upon the occurrence of a heavy current overload, or short circuit condition, and thermally responsive means for tripping the circuit breaker upon the occurrence of a persistent overload current of lesser magnitude.

In general, a circuit breaker of the type with which the present invention is concerned comprises a pair of separable contacts, an over-center spring type operating mechanism for opening and closing the contacts, and a current responsive tripping mechanism for releasably latching the operating mechanism. The tripping mechanism functions magnetically to release the operating mechanism substantially immediately upon the occurrence of a heavy current overload, or thermally to release the operating mechanism after a predetermined interval of time in response to a continued moderate current overload.

An object of the invention is to provide an improved circuit breaker.

Another object is to provide a circuit breaker having an improved means for compensating for manufacturing tolerances in the operating mechanism thereof.

A further object is to provide a circuit breaker having an improved arrangement of the bimetallic portion of a tripping mechanism with respect to a terminal of the circuit breaker, whereby heat developed in the bimetal is well dissipated to reduce the amount of heat transferred from the bimetal to the terminal, and the bimetal can thereby be designed to provide more accurate control by operating at a higher temperature.

Yet another object is to provide a circuit breaker having an improved venting arrangement for gases which may be formed upon separation of the contacts of the circuit breaker.

A still further object is to provide a circuit breaker having an improved handle arm and spring support assembly for the operating mechanism thereof.

Another object is to provide a circuit breaker having an improved mounting and biasing arrangement for an intermediate latch member of a tripping mechanism of the circuit breaker.

A further object is to provide a circuit breaker having an improved armature arrangement for a tripping mechanism of the circuit breaker.

Still another object is to provide a circuit breaker having an improved handle shield for an operating handle thereof.

Other objects will appear when the following description is considered in conjunction with the accompanying drawings in which:

FIG. 1 is a front view of a circuit breaker constructed in accordance with the invention, a few of the parts inside the casing of the circuit breaker being shown by broken lines;

FIG. 2 is a rear view of the circuit breaker of FIG. 1;

FIG. 3 is an enlarged front view of the circuit breaker of FIG. 1 with the cover and certain other parts removed;

FIG. 4 is an enlarged fragmentary sectional view of the circuit breaker of FIG. 1 taken generally along the line 4-4 of FIG. 3 and showing the center pole of the

circuit breaker in "on" position but omitting the arc chute;

FIG. 4a is a perspective view of the spring support member on the handle arm assembly of the circuit breaker of FIG. 1;

FIG. 5 is a view similar to FIG. 4, but showing the center pole of the circuit breaker in "tripped" position;

FIG. 5a is a sectional view taken generally along the line 5a-5a of FIG. 5;

FIG. 5b is a sectional view of a portion of the mechanism of FIG. 5 taken generally along the line 5b-5b of FIG. 5a;

FIG. 6 is a view similar to FIG. 4, but showing the center pole of the circuit breaker in "off" position;

FIG. 6a is a fragmentary side elevational view of the frame for the operating mechanism of the circuit breaker of FIG. 1 and certain parts pivotally mounted therein;

FIG. 6b is a fragmentary view taken in the direction of arrows 6b-6b of FIG. 6a and showing the intermediate latch member, the frame members in which it is mounted being shown in section;

FIG. 7 is a sectional view taken generally along the line 7-7 of FIG. 3 and showing one of the outer poles of the circuit breaker in "on" position;

FIG. 8 is a sectional view taken generally along the line 8-8 of FIG. 4;

FIG. 9 is a sectional view taken generally along the line 9-9 of FIG. 4;

FIG. 10 is a view of the common trip bar of the circuit breaker of FIG. 1 showing the edge of the latch plate which forms a latch surface;

FIG. 11 is a view similar to FIG. 10, but showing a flat side of the latch plate; and

FIG. 12 is a sectional view taken along the line 12-12 of FIG. 11.

For exemplary purposes, the invention is shown and described with respect to a three-pole circuit breaker, although it will be obvious that various aspects of the invention are equally applicable to circuit breakers of a different number of poles. The three-pole circuit breaker constructed in accordance with the invention includes a two-part case having a base 20 and a cover 22, and an operating handle 24, all preferably molded of an insulating material. The base 20 and cover 22 are preferably secured together by two pairs of rivets 26 disposed respectively adjacent opposite ends of the case in partition walls separating the three poles of the circuit breaker. The cover 22 has an opening 23 for receiving the outer end of the handle 24 and is provided with suitable "on" and "off" indicia.

The handle 24 has an integral inner arcuate shoulder portion 25 generally concentric with an inner arcuate surface 27 of the cover 22. A thin generally rectangular shield 28 for the handle opening 23 is mounted on the handle 24 and trapped between the inner surface 27 and the shoulder portion 25. The shield 28 is preferably formed of a tough, resilient insulating material such as glass-fiber-reinforced polyester plastic and is provided with a generally rectangular aperture 29 for receiving the handle 24.

Each pole of the circuit breaker is provided at one end with an electrical connector 30 normally used as a line terminal and at the other end with a preferably identical electrical connector 32 normally used as a load terminal.

The base 20 includes a bottom or rear wall portion 21 from which a pair of parallel outer side wall portions 34 and 35 and a pair of parallel inner wall portions 36 and 37, (FIGS. 3, 8, and 9) extend perpendicularly. The inner wall portions 36 and 37 separate the three poles of the circuit breaker but are upwardly recessed in two places for respectively receiving a common trip bar 39 and a contact arm crossbar 40 both of which extend

transversely of the three poles and are described hereinafter. The opposite end portions of the wall portions 34, 35, 36, and 37 are thickened as shown in FIG. 3, the rivets 26 being received in the thickened portions of the inner wall portions 36 and 37.

The cover 22 includes wall portions 34a, 35a, 36a, and 37a generally corresponding to the wall portions 34, 35, 36, and 37. The inner wall portions 36 and 37 of the base and the corresponding inner wall portions 36a and 37a of the cover are grooved to receive a pair of vulcanized fiberboard inserts or stops 41 which limit the opening movement of the crossbar 40. The stops 41 are shown in FIG. 3 in place on the base 20 for purpose of illustration, but preferably they are secured in any suitable manner in the cover 22 as shown in FIG. 9.

Each pole of the circuit breaker includes a stationary contact 42, a contact arm 43 pivotally mounted adjacent one end, and a movable contact 44 carried adjacent the free end of the respective contact arm and engageable with its associated stationary contact.

Each stationary contact 42 is secured, as by brazing, to the inner end of a bronze line terminal strap 46 having one of the line terminals 30 secured to the outer end thereof, as shown best in FIG. 7. The line terminals 30 and load terminals 32 are constructed in accordance with copending application, Ser. No. 188,614, filed Apr. 13, 1962, now Patent No. 3,187,299, and assigned to the assignee of this invention. The terminals respectively include rectangular aluminum body portions 48 which are respectively apertured endwise of the circuit breaker to receive aluminum or copper wires and are respectively provided with wire clamping screws 50.

The base 20 includes a plurality of platform portions 52, one at each end of each pole of the circuit breaker. Each platform portion 52 interconnects a pair of the wall portions 34, 35, 36, and 37 of the base 20. The outer end portions of the line terminal straps 46 are respectively held on their associated platform portions 52 by brass sleeves 54 having outer hexagonal head portions as shown in FIG. 2. Preferably the line terminal straps 46 are provided with countersunk holes for receiving the inner ends of the sleeves 54, and the sleeves are spun over the terminal straps within the countersunk portions thereof in order to provide flush surfaces for good electrical contact between the line terminal straps and the associated body portions 48 of the line terminals 30. The body portions 48 are tightly clamped respectively to the line terminal straps by brass screws 56 threaded respectively into the sleeves 54 before the clamping screws 50 are threaded into the body portions 48. The sleeves 54 are prevented from turning by engagement of one side of the hexagonal head portions respectively with adjacent flat surfaces on the base 20, as shown in FIG. 2.

Each pole of the circuit breaker is provided with an arc runner 58 secured to its respective line terminal strap 46 adjacent the stationary contact 42 thereon. Further, each pole is provided with an arc chute including a plurality of ferrous de-ionizing plates 60 mounted in closely spaced relationship to each other in a pair of spaced insulating fiberboard members 61 as shown in FIGS. 3 and 7. The plates 60, omitted in FIGS. 4, 5, and 6 for convenience, are generally rectangular with relatively large, generally V-shaped notches in one end for the passage of the movable contact 44 of the respective pole, and may be provided with laterally extending tongues (not shown) staked or peened over to retain the members 61 thereon. Also mounted between each pair of members 61 is an insulating fiberboard barrier 62 provided with perforations 63 adjacent the upper end thereof as viewed in FIG. 7 for the venting of gases which may be formed upon interruption of large currents. Preferably each pole is provided with an additional fiberboard barrier 64 disposed between the respective barrier 62 and line terminal 30 and having perforations 65 adjacent the upper end thereof as viewed in FIG. 7 for the venting of gases. A fiberboard barrier 66 is provided in each pole adjacent the notched ends of

the plates 60 and is slotted, as best shown in FIG. 9 for the two outer poles, for the reception of the respective contact arm 43. Thus, an arc chamber for each pole is defined by the base 20, the cover 22, a barrier 62, a barrier 66, and a pair of members 61.

In accordance with the invention, another venting arrangement is provided in addition to the perforations 63 and 65 in the barriers 62 and 64, respectively, of each pole. Thus, as shown in FIGS. 2, 4, 5, 6, and 7, a transverse passageway 68 opening to opposite sides of the circuit breaker through the outer side wall portions 34 and 35 is provided. The passageway 68 is formed as a groove in the bottom wall portion 21 the groove being covered by an insulating plate 69 recessed in the bottom wall portion 21 and held in place by three lugs 70 formed integrally with the base 20 and extending over the right-hand edge of the plate 69 as viewed in FIG. 2, and by a pair of drive screws 71 adjacent the left-hand edge. The arc chambers of the three poles of the circuit breaker communicate respectively with the passageway 68 through three connecting passageways 72, 73, and 74. A curved projection 75 in the passageway 68 diverts the flow of gases from the arc chamber of the center pole of the circuit breaker toward opposite ends of the passageway 68.

The handle 24 is operatively connected to an over-center spring mechanism disposed in the center pole and shown in FIGS. 3, 4, 5, 6, and 9. Thus, the cover 22 holds the shoulder portion 25 of the handle 24 in operative association with a handle arm assembly and a generally T-shaped spring support member 78 for a tension spring 77, the handle arm assembly including a pair of generally triangular side plate or handle arm members 79 and 80 pivotally mounted adjacent their ends remote from the handle 24 on a pin 82.

In accordance with the invention, the dimension of the aperture 29 in a direction parallel to the side wall portions 34 and 35 is considerably larger than the thickness of the handle 24 measured in the same direction, although the shoulder portion 25 completely covers the aperture 29 in any relative position of the handle 24 and shield 28. The lost-motion connection between the handle 24 and shield 28 provided by the relatively large aperture 29 reduces the amount of movement of the shield 28 as the handle is operated in comparison to the amount of movement which would result if the aperture were of substantially the same size as the handle, and therefore the lost-motion connection reduces the length of the shield 28 required to maintain the seal of the opening 23 by the shield 28 in all positions of the handle 24. The reduction in the length of the shield 28 in comparison to the length required in former constructions enables the breaker to be made smaller.

A pin 84 is rigidly mounted adjacent opposite ends respectively in the handle arm members 79 and 80 to complete the handle arm assembly. Preferably the handle arm members are countersunk and the opposite ends of the pin 84 are spun over within the countersunk portions to hold the handle arm members respectively against shoulders provided adjacent opposite ends of the pin, as will be understood. The spring support member 78 is shown best in FIG. 4a. A free end portion 78a of the trunk of the T-shaped spring support member 78 is curved partially around the pin 84, and a pair of free end portions 78b and 78c of the head of the T-shaped spring support member are respectively bent over to engage the outer sides of the plate members 79 and 80, which are inwardly offset adjacent their right-hand ends as viewed in FIG. 3. The trunk of the T-shaped spring support member 78 is narrowed down as at 78d for retaining an end of the spring 77. The cover 22, handle 24, part of spring 77, spring support member 78, and pin 84 have been omitted in FIG. 3 for clarity.

The pin 82 is mounted in a pair of frame members 87 and 88 which are respectively disposed inwardly of but closely adjacent the plate members 79 and 80 and are respectively secured to the base wall portion 21 by a pair

of screws 90, as best shown in FIG. 9, the screws 90 preferably being self-tapping and the frame members 87 and 88 being lanced to provide oppositely projecting loops 91 into which the screws 90 are threaded.

The contact arm 43 of the center pole is pivotally mounted adjacent one end on the pin 82 centrally thereof. Also mounted on the pin 82 is a generally U-shaped drive arm 92 for the crossbar 40, the free end portions of the leg portions of the drive arm 92 being pivotally mounted on the pin 82 and the bight portion of the drive arm 92 being riveted or otherwise secured to the crossbar 40.

The contact arms 43 of the two outer poles are pivotally mounted respectively on a pair of pins 83. The opposite end portions of one of the pins 83 are mounted in appropriate slots in the wall portions 34 and 36, respectively, as best shown in FIG. 9, while the opposite end portions of the other pin 83 are mounted in appropriate slots in the wall portions 35 and 37, respectively. The pins 83 are respectively retained in their respective slots by a pair of generally U-shaped fiberboard retainers 85 which are held between the pins 83 and the pair of wall portions 34a and 36a and the pair of wall portions 35a and 37a, respectively, of the cover 22.

Each contact arm 43 is resiliently secured to the crossbar 40 by means of a hairpin-shaped or generally U-shaped spring 93 having a bight portion disposed in a suitable notch in the end of the respective contact arm 43 opposite from the respective contact 44. The leg portions of each spring 93 are disposed on opposite sides of the respective contact arm and are resiliently curved over a pin 94 frictionally held in and extending transversely through the contact arm, the free end portions of the leg portions of each spring 93 being received and held in appropriate slots in the crossbar 40.

A generally U-shaped cradle member of trip lever 96 is pivotally mounted on the frame members 87 and 88, one leg portion 96a of the trip lever being pivotally mounted on the frame member 87 by a rivet 97 and the other leg portion 96b of the trip lever being pivotally mounted on the frame member 88 by a rivet 98, as best shown in FIG. 3.

A pair of upper links 101 and 102 are pivotally mounted adjacent their upper ends on the trip lever 96, the link 101 being pivotally mounted on the leg portion 96a by a rivet 103 and the link 102 being pivotally mounted on the leg portion 96b by a rivet 104. The lower end portions of the links 101 and 102 are pivotally mounted on a toggle pin 105 shown best in FIG. 5a, the lower end portions of the links being provided with open-ended slots as shown in FIGS. 4, 5, and 6 for respectively receiving reduced diameter portions 105a and 105b (FIG. 5a) of the toggle pin. The spring 77 is anchored at one end on the spring support member 78 and at the other end on the toggle pin 105.

In accordance with the invention, an adjustable connection is provided between the toggle pin 105 and the drive arm 92 to provide a means of compensating for manufacturing tolerances between the various parts. Thus, a pair of lower links 107 are pivotally mounted adjacent their upper ends on the toggle pin 105 respectively inwardly of the upper links 101 and 102, and are pivotally mounted adjacent their lower ends on a bushing 108 shown best in FIGS. 5a and 5b. One leg portion of the drive arm 92 is provided with a hexagonal aperture for receiving a hexagonal head portion 109 of a pin 110 having an eccentric cam portion 111 received within the bushing 108. The other leg portion of the drive arm 92 is provided with a circular hole for receiving the end of the pin 110 opposite the hexagonal head portion 109. The adjustment afforded by the pin 110 is a factory calibration. After bench testing of the mechanism of the center pole, the head portion 109 of the pin 110 is inserted in the corresponding aperture in the drive arm 92 in the most suitable of its six possible relative positions to best compensate for manufacturing tolerances by the eccentric cam portion 111.

When the handle 24 is moved from the "on" position of FIG. 4 to the "off" position of FIG. 6, the direction of the force exerted by the spring 77 on the toggle pin 105 is shifted across the pivotal mountings of the upper end portions of the upper links 101 and 102, and the toggle pin 105 is pivoted counterclockwise about the rivets 103 and 104 from the position thereof as viewed in FIG. 4 to the position thereof as viewed in FIG. 6, the lower links 107 acting through the drive arm 92 and crossbar 40 to move the contact arms 43 of the three poles to the "open" position to separate the respective pairs of contacts 42 and 44. The action is reversed when the handle 24 is moved from the "off" position of FIG. 6 back to the "on" position of FIG. 4.

The trip lever 96 is releasably latched in the position thereof shown in FIGS. 4 and 6 by a double latching arrangement. Thus, as best shown in FIGS. 6a and 6b, the frame members 87 and 88 are provided respectively with a pair of aligned slots 113 and 114 for respectively receiving opposite end portions of a pin 16 which is rigidly secured as by welding to a generally V-shaped intermediate latch member 118. The bight portion of the trip lever 96 is provided with an angularly extending tongue 119 engageable with a latch surface 120 of the latch member 118, the latch surface 120 defining one edge of a slot 121 provided in the latch member 118 before it is formed into its generally V-shaped configuration. The latch member 118 is provided with a tongue 122 engageable with a latch surface 123 (FIG. 10) provided by an edge of a latch plate 124 secured as by a rivet 125 (FIGS. 10, 11, and 12) to the common trip bar 39, which is mounted for limited pivotal movement in the wall portions 36 and 37. When the trip lever 96 is latched as shown in FIG. 4, the spring 77 acts through the toggle pin 105, upper links 101 and 102, and rivets 103 and 104 to bias the trip lever counterclockwise as viewed in FIG. 4, the trip lever in turn biasing the latch member 118 clockwise. When the common trip bar 39 is pivoted clockwise as viewed in FIG. 4, the latch surface 123 of the latch plate 124 is pivoted out from under the tongue 122 and the latch member 118 pivots clockwise to release the trip lever 96, which then pivots counterclockwise about the pin 98 to the "tripped" position thereof shown in FIG. 5. The pivoting of the trip lever 96 to tripped position pivots the rivets 103 and 104 counterclockwise about the pin 98 and releases the restraining force of the upper links 101 and 102 on the toggle pin 105, allowing the spring 77 to pull the toggle pin upwardly, the lower links 107 then acting through the drive arm 92 and crossbar 40 to move the contact arms 43 of the three poles to the open or "tripped" position to separate the respective pairs of contacts 42 and 44. The spring 77 also causes the handle 24 to move to "tripped" position.

The pivoting of the common trip bar 39 clockwise as viewed in FIGS. 4-7 to trip the circuit breaker may be effected thermally upon sustained moderate overloads or magnetically upon severe overloads. Thus, each pole of the circuit breaker is provided with a bronze load terminal strap 126 having an outer end portion clamped to a load terminal 32 in the same manner in which the line terminal straps 46 are clamped to the line terminals 30. In accordance with the invention, the terminal straps 126 are constructed and arranged to extend from the respective load terminals 32 for a considerable distance along the bottom wall portion 21 and in intimate contact therewith for a substantial portion of their length. Each pole is also provided with a bimetallic strip 128 secured adjacent one end as by soldering to the inner end portion of the respective terminal strap 126 and having a flexible conductor 130, preferably in the form of a braided cable, secured thereto adjacent the other end. The relatively long length of the terminal straps 126 and their direct contact with the bottom wall portion 21 result in good dissipation of heat through the bottom wall portion 21 and in a larger temperature gradient than in former constructions between bimetallic strips and their associated load terminals,

enabling the bimetallic strips 128 to be operated at higher temperatures than those of former constructions without causing excessive temperature rise at the respective load terminals. The cables 130 are also secured to the respective contact arms 43 to electrically connect the bimetallic strips to the contact arms. The common trip bar 39 is provided with three projecting lugs 132, one in each pole adjacent the free end portion of the respective bimetallic strip. Upon the occurrence of a sustained moderate overload current flow in any of the terminal straps 126, the respective bimetallic strip 128 will deflect enough to engage its respective lug 132 and pivot the common trip bar 39 clockwise as viewed in FIGS. 4-7 to release the tongue 122 from the latch surface 123 of the latch plate 124 and trip the circuit breaker as explained above. Each terminal strap 126 is secured centrally thereof to the bottom wall portion 21 by a screw 134 threaded thereto from the exterior of the casing. Further, the interior surface of the bottom wall portion 21 is inclined away from the inner end portion of the terminal strap 126 in each pole, as at 135, and in each pole a calibrating screw 136 is threaded through the inner end portion of the terminal strap. If desired, in each pole a washer 137 may be secured to the terminal strap to provide additional thread bearing area. The position of a bimetallic strip 128 in relation to the respective lug 132 on the trip bar 39 may be adjusted by turning the respective calibrating screw 136 to effect bending of the respective terminal strap 126.

It is a requirement that the temperature rise at the load terminals of a circuit breaker be limited. The good heat dissipation resulting from the relatively long length of the terminal strap 126 in each pole and the direct contact thereof with the bottom wall portion 21 allows the bimetallic strip to be calibrated to trip the circuit breaker at a relatively high temperature of the bimetallic strip without exceeding the permitted temperature rise at the respective load terminal. Operation of the bimetallic strip at higher temperatures than formally substantially eliminates nuisance tripping due to high ambient temperatures and also renders the latching pressures less critical.

Each pole of the circuit breaker is provided with a stiff insulating barrier 140 adjacent the respective load terminal 32. Riveted or otherwise secured to the inner surface of the insulating barrier 140 of each outer pole is a generally L-shaped bracket 142. A similar bracket 143 is secured to the barrier 140 of the center pole, the bracket 143 having two additional portions in comparison with the brackets 142.

In each outer pole, a portion 144 of the bracket 142 extends perpendicularly to the respective barrier 140 and is provided with a pair of apertures one of which reciprocally receives an internally threaded sleeve 148 slotted at its upper end and flanged at its lower end, and the other of which receives a hooked end of a tension spring 150.

In the center pole, a portion 145 of the bracket 143 also is apertured to receive a sleeve 148 and an end of a spring 150, but the portion 145 is larger than the portions 144 of the brackets 142 and supports a spring 152 formed from flat stock and acting as a return spring for the latch member 118. The spring 152 biases the latch member counterclockwise as viewed in FIGS. 4, 5, and 6, and also biases the pin 116 upwardly in the slots 113 and 114, which are provided to allow shifting of the latch member by the tongue 119 of the trip lever 96 during resetting or relatching of the circuit breaker after tripping has occurred. A portion 146 of the bracket 143 supports a stop screw 154 which is engageable with a lug 156 on the trip bar 39 and adjustable to limit the amount of engagement between the tongue 122 and the latch surface 123 of the latch plate 124 and thus determine the latching pressure. A bent-over tongue 157 on the portion 145 of the bracket 143 is engageable with the tongue 122 of the latch member 118 to limit the pivotal movement thereof in the counterclockwise direction as viewed in FIGS. 4, 5, and 6.

The common trip bar 39 is normally biased in the counterclockwise direction as viewed in FIGS. 4, 5, 6,

and 7 against an edge of the slots in the wall portions 36 and 37 in which it is mounted by a pair of springs 160 formed from flat stock and respectively located in the two outer poles. One end of each spring 160 is anchored in the respective barrier 140, and the other end of each spring 160 is forked to receive and bear against a respective small lug 162 on the trip bar.

Each sleeve 148 is threaded on an armature rod 164 having an armature 166 rigidly secured thereon between a pair of collars 167. The lower end portion of each armature rod 164 is reciprocally received in an eyelet 168 secured in the respective terminal strap 126. Each armature 166 is adapted to be attracted into engagement with a generally U-shaped magnetic core member 170 upon a severe overload. Each core 170 is secured in a recess in the bottom wall portion 21 beneath its respective terminal strap 126 by a spring member 172. Thus, the amount of current flowing in each terminal strap 126 determines the magnitude of the magnetic pull of the associated core 170 on its associated armature 166. As best shown in FIG. 8, the cores 170 and spring members 172 are centrally apertured and the bottom wall portion 21 is suitably recessed for receiving the lower end portions of the respective armature rods 164 upon attraction of the respective armatures 166 into engagement with their respective cores 170.

The common trip bar 39 is provided with three pairs of lugs 174 as best shown in FIGS. 10 and 11. Each armature rod 164 is straddled by one pair of the lugs 174. Upon the occurrence of a severe overload current flow in any one of the terminal straps 126, the respective armature 166 will be attracted into engagement with its respective core 170, and the respective sleeve 148 will engage its respective pair of lugs 174 and pivot the common trip bar 39 clockwise as viewed in FIGS. 4-7 to release the tongue 122 from the latch surface 123 of the latch plate 124 and trip the circuit breaker as explained above. The tension springs 150 are respectively secured at their lower ends to the armatures 166 to bias the armatures away from their respective cores 170.

The common trip bar 39 is provided with two pairs of spaced circular portions 175 each pair of which straddles one of the inner wall portions 36 and 37 of the base 20 to maintain the trip bar in proper position axially thereof. As best shown in FIGS. 3 and 7, a pair of vulcanized fiberboard insulating members 176 are disposed respectively in the wall portions 36 and 37 in straddling relationship to the common trip bar 39 to close off the slots in the wall portions between poles.

It will be seen that I have provided an improved means for compensating for manufacturing tolerances in the operating mechanism of a circuit breaker, and that I have provided an improved arrangement of the bimetallic portions of a tripping mechanism with respect to the respective load terminals of a circuit breaker. Further, an improved venting arrangement for a circuit breaker has also been provided, along with an improved armature arrangement for a tripping mechanism. In addition, I have provided an improved handle shield for the operating handle of a circuit breaker and an improved mounting and biasing arrangement for an intermediate latch member of a tripping mechanism of a circuit breaker.

The terms "upper," "lower," "top," "bottom," "rear," etc., as used herein and in the appended claims are purely relative, it being understood that the circuit breaker of the invention may be mounted in various positions.

Various modifications may be made in the structure shown and described without departing from the spirit and scope of the invention.

I claim:

1. An electric circuit breaker comprising a stationary contact, a movable contact arm pivotally mounted adjacent one end, a movable contact carried by said contact arm adjacent the other end for cooperation with said stationary contact, a drive arm pivotally mounted adjacent one end, a crossbar carried by said drive arm adjacent the

other end and extending transversely of said contact arm generally parallel to the axis of pivotal movement thereof, means yieldably connecting said contact arm and crossbar, a pivotally mounted operating handle, and an adjustable overcenter spring type toggle mechanism operatively connecting said operating handle and drive arm, the axes of pivotal movement of said contact arm, drive arm, and operating handle being collinear.

2. An electric circuit breaker comprising a stationary contact, a movable contact arm pivotally mounted adjacent one end, a movable contact carried by said contact arm adjacent the other end for cooperation with said stationary contact, a drive arm pivotally mounted adjacent one end, a crossbar carried by said drive arm adjacent the other end and extending transversely of said contact arm generally parallel to the axis of pivotal movement thereof, means yieldably connecting said contact arm and crossbar, a pivotally mounted operating handle, an upper link pivotally mounted adjacent an upper end, a lower link, a toggle pin pivotally connecting a lower end portion of said upper link and an upper end portion of said lower link, a tension spring operatively connected adjacent opposite ends respectively to said operating handle and said toggle pin, and adjustable connecting means adjustably connecting a lower end portion of said lower link and said drive arm.

3. An electric circuit breaker as claimed in claim 2, wherein said adjustable connecting means includes a bushing carried by said lower link adjacent its lower end and a pin having an eccentric cam portion disposed in said bushing for rotary movement with respect thereto, said pin being selectively mountable in said drive arm in a plurality of different angular positions with respect thereto.

4. An electric circuit breaker comprising a case, a stationary contact in said case, a pair of frame members secured in said case in spaced relationship to each other, a generally U-shaped releasably latchable trip lever having a pair of leg portions pivotally mounted respectively on said frame members, a mounting pin supported by said frame members, a movable contact arm pivotally mounted adjacent one end on said mounting pin, a movable contact carried by said contact arm adjacent the other end for cooperation with said stationary contact, a generally U-shaped drive arm having a pair of leg portions pivotally mounted on said mounting pin, a crossbar secured to a bight portion of said drive arm and extending generally parallel to said mounting pin, means yieldably connecting said contact arm and crossbar, an operating handle extending outwardly of said case and including a pair of side plate members pivotally mounted on said mounting pin, a pair of upper links pivotally mounted adjacent their upper ends respectively on said leg portions of said trip lever, a pair of lower links, a toggle pin pivotally connecting the lower end portions of said upper links respectively with the upper end portions of said lower links, a tension spring operatively connected adjacent opposite ends respectively to said operating handle and said toggle pin, a bushing carried by said lower links adjacent their lower ends, and a rotatably adjustable pin having an eccentric cam portion disposed in said bushing for rotary movement with respect thereto, said adjustable pin being selectively mountable adjacent opposite ends in the leg portions of said drive arm in a plurality of different angular positions with respect thereto.

5. An electric circuit breaker comprising an elongated generally rectangular casing, a pair of terminals mounted on said casing respectively adjacent opposite ends thereof, a first terminal strap having an outer end portion electrically connected to one of said terminals, a stationary contact secured to an inner end portion of said first terminal strap, an elongated contact arm pivotally mounted adjacent one end, a movable contact secured to said contact arm adjacent the other end for cooperation with said stationary contact, said contact arm ex-

tending generally parallel to the direction of the longest dimension of said case when said contacts are in closed position, a releasably latchable trip lever releasable from a latched position to effect separation of said contacts, a pivotally mounted trip bar disposed between the other of said terminals and the pivotal mounting of said contact arm and being pivotable from a latching position to effect release of said trip lever from said latched position and cause separation of said contacts, a second terminal strap having an outer end portion electrically connected to said other of said terminals, the greater portion of the length of said second terminal strap extending generally parallel to said direction of said longest dimension of said case, the length of said second terminal strap being such as to dispose an inner end portion thereof inwardly of said pivotal mounting of said contact arm, a bimetallic strip secured adjacent one end to said inner end portion of said second terminal strap, the other end portion of said bimetallic strip being free to move and being engageable with said trip bar to pivot it from said latching position upon sustained flow of moderate overload current through said bimetallic strip, and a flexible conductor electrically connecting the free end portion of said bimetallic strip and the pivotally mounted end portion of said contact arm.

6. An electric circuit breaker as claimed in claim 5, wherein the length of said second terminal strap is such as to dispose said inner end portion thereof closer to said stationary contact than to the pivotal mounting of said contact arm.

7. An electric circuit breaker comprising a casing including a wall portion having a curved inner surface and an elongated slot extending through said wall portion, a pair of separable contacts in said casing, an operating handle mounted in said casing for pivotal movement about an axis spaced inwardly of said wall portion and operatively connected to one of said contacts to effect opening and closing thereof, said handle including an outer portion extending outwardly of said casing through said elongated slot and reciprocable longitudinally therein, said handle including an inner shoulder portion having a curved outer surface generally complementary to said curved inner surface of said wall portion of said casing, and a resiliently flexible sealing member formed from a flat sheet of material and mounted on said outer portion of said handle and disposed between said wall portion of said casing and said inner shoulder portion of said handle, said sealing member extending from said outer portion of said handle longitudinally of said slot sufficiently to completely overlap said slot in all positions of said handle, said sealing member having a hole there-through for receiving said outer portion of said handle, and the dimension of said hole measured longitudinally of said slot being substantially larger than the dimension of said outer portion of said handle measured longitudinally of said slot, whereby a lost-motion connection is provided between said outer portion of said handle and said sealing member, and said sealing member moves shorter distances longitudinally of said slot than does the curved outer surface of the inner shoulder portion of said handle upon operation of said handle.

8. An electric circuit breaker comprising a casing, a pair of separable contacts in said casing, an operating handle operatively connected to one of said contacts to effect opening and closing thereof, said operating handle being formed of insulating material and having an outer portion extending outwardly of said casing and an inner shoulder portion, a handle arm assembly including a pair of spaced side plate members pivotally mounted in said casing adjacent their inner ends and joined at one portion thereof by a pin adjacent their outer ends, and a generally T-shaped spring support member disposed adjacent said outer ends of said side plate members, the free end portion of the trunk portion of said T-shaped spring support member being curved partially around said pin, the free

end portions of the head portion of said T-shaped spring support member being bent respectively over said side plate members at another portion thereof adjacent their outer ends, and said inner shoulder portion of said handle being held in associated relationship with said side plate members, pin, and spring support member by said casing.

9. An electric circuit breaker comprising an elongated generally rectangular casing, a pair of separable contacts in said casing, a releasably latchable trip lever mounted in said casing and releasable from a latched position to effect separation of said contacts, a terminal mounted on said casing adjacent one end thereof, a trip bar mounted in said casing between said trip lever and said terminal and pivotable from a latching position to effect release of said trip lever from a latched position and cause separation of said contacts, a terminal strap having an outer end portion electrically connected to said terminal and an inner portion extending generally parallel to the direction of the longest dimension of said case along a bottom wall portion thereof, a magnetizable core member recessed in said bottom wall portion beneath said inner portion of said terminal strap, an armature rod mounted in said casing for axially reciprocal movement perpendicular to said bottom wall portion, and an armature fixedly mounted on said armature rod and biased away from said core member and adapted to be attracted along with said armature rod toward said core member upon flow of severe overload current through said terminal strap, one end portion of said armature rod extending through said terminal strap, and the other end portion of said armature rod having a member secured thereto and adapted to engage and pivot said trip bar upon attraction of said armature toward said core.

10. An electric circuit breaker as claimed in claim 9, wherein said member on said other end portion of said armature rod is a threaded sleeve adjustably mounted on said armature rod to vary the overload current value at which it will pivot said trip bar.

11. In an electric circuit breaker having a casing including a wall portion having a curved inner surface and an elongated slot extending through said wall portion, an operating handle formed of insulating material and including an outer handle portion and an inner shoulder portion, said outer handle portion extending outwardly of said casing through said elongated slot and being reciprocable longitudinally thereof, a stationary contact in said casing, a pair of spaced frame portions secured in said casing, a generally U-shaped releasably latched trip lever having a pair of leg portions disposed between and pivotally mounted respectively on said frame portions, a pair of upper links pivotally mounted adjacent their upper ends respectively on said leg portions of said trip lever, a pair of lower links, a toggle pin pivotally connecting the lower end portions of said upper links respectively to the upper end portions of said lower links, a mounting pin supported by said frame portions, a movable contact arm pivotally mounted adjacent one end on said mounting pin, a movable contact carried by said contact arm adjacent the other end thereof and movable thereby into and out of engagement with said stationary contact, a generally U-shaped arm including a bight portion and a pair of spaced leg portions pivotally mounted on said mounting pin and straddling said contact arm, a crossbar secured to said bight portion of said drive arm and extending generally parallel to said mounting pin, and means yieldably connecting said contact arm and crossbar, the improvement comprising a handle arm assembly including a pair of spaced generally triangular side plate members straddling said frame portions and a fastening pin connecting first vertex portions of said side plate members, said side plate members being pivotally mounted adjacent second vertex portions thereof respectively on opposite end portions of said mounting pin, a generally T-shaped spring support member disposed adjacent the

edges of said side plate members opposite said second vertex portions, the free end portion of the trunk portion of said T-shaped spring support member being curved partially around said fastening pin and the free end portions of the head portion of said T-shaped spring support member being bent respectively over said side plate members adjacent third vertex portions thereof, a tension spring operatively connected adjacent opposite ends respectively to said trunk portion of said T-shaped spring support member and to said toggle pin, a bushing carried by the lower end portions of said lower links, a rotatably adjustable pin having an eccentric cam portion disposed in said bushing and adapted to be rotatably adjusted with respect thereto, said adjustable pin being selectively mountable adjacent opposite ends in the leg portions of said drive arm in a plurality of different angular positions with respect thereto, said inner shoulder portion of said handle having a curved outer surface generally complementary to said curved inner surface of said wall portion of said casing and having a recessed inner surface generally complementary to said handle arm assembly and spring support member, said wall portion of said casing holding said operating handle and handle arm assembly in assembled relationship for pivotal movement as a unit about said mounting pin, and a resiliently flexible sealing member disposed between said wall portion of said casing and said inner shoulder portion of said handle, said sealing member having a hole through which said outer handle portion extends, said sealing member having a length sufficient to completely overlap said slot in all positions of said operating handle, and said hole being sufficiently larger than said outer handle portion in the longitudinal direction of said slot to provide a lost-motion connection between said outer handle portion and said sealing member.

12. In an electric circuit breaker having an elongated generally rectangular casing, a pair of terminal connectors mounted on said casing respectively adjacent opposite ends thereof, a first terminal strap having an outer end portion electrically connected to one of said terminal connectors, a stationary contact secured to an inner end portion of said first terminal strap, an elongated contact arm pivotally mounted adjacent one end, a movable contact secured to said contact arm adjacent the other end thereof and movable thereby into and out of engagement with said stationary contact, a releasably latchable trip lever mounted in said casing and releasable from a latched position to effect separation of said contacts, and a trip bar pivotally mounted in said casing between the other of said terminal connectors and the pivotal mounting of said contact arm and pivotable from a latching position to effect release of said trip lever from said latched position and cause separation of said contacts, the improvement comprising a second terminal strap having an outer end portion electrically connected to said other terminal connector and having a relatively long inner portion extending generally parallel to the direction of the longest dimension of said casing along a bottom wall portion thereof, the length of said inner portion being such as to dispose an inner end portion thereof on the opposite side of said pivotal mounting of said contact arm from said other terminal connector, a bimetallic strip secured adjacent one end to said inner end portion of said inner portion of said second terminal strap, the other end portion of said bimetallic strip being free to move and being engageable with said trip bar to pivot it from said latching position upon sustained flow of moderate overload current through said bimetallic strip, a flexible conductor electrically connecting said bimetallic strip and said contact arm, a magnetizable core member recessed in said bottom wall portion of said casing beneath said inner portion of said second terminal strap, an armature rod mounted in said casing between said trip bar and said other terminal connector for axially reciprocal movement perpendicular to said bottom wall portion of said casing, and an armature

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mounted on said armature rod and biased away from said core member and attractable with said armature rod toward said core member upon flow of severe overload current through said second terminal strap, said inner portion of said second terminal strap having a hole there-through for reception of one end portion of said armature rod, and the other end portion of said armature rod having means engageable with said trip bar to pivot it from said latching position upon attraction of said armature toward said core member.

13. In an electric circuit breaker having an elongated generally rectangular casing including a wall portion having a curved inner surface and an elongated slot extending through said wall portion, an operating handle formed of insulating material and including an outer handle portion and an inner shoulder portion, said outer handle portion extending outwardly of said casing through said elongated slot and being reciprocable longitudinally thereof, a pair of terminal connectors mounted on said casing respectively adjacent opposite ends thereof, a first terminal strap having an outer end portion electrically connected to one of said terminal connectors, a stationary contact secured to an inner end portion of said first terminal strap, a pair of spaced frame portions secured in said casing, a mounting pin supported by said frame portions, an elongated movable contact arm pivotally mounted adjacent one end on said mounting pin, a movable contact secured to said contact arm adjacent the other end thereof and movable thereby into and out of engagement with said stationary contact, a generally U-shaped releasably latchable trip lever having a pair of leg portions disposed between and pivotally mounted respectively on said frame portions, a pair of upper links pivotally mounted on said casing adjacent their upper ends respectively on said leg portions of said trip lever, a pair of lower links, a toggle pin pivotally connecting the lower end portions of said upper links respectively to the upper end portions of said lower links, a trip bar pivotally mounted in said casing between the other of said terminal connectors and said mounting pin and pivotable from a latching position to effect release of said trip lever from a latched position and cause separation of said contacts, a generally U-shaped drive arm including a bight portion and a pair of spaced leg portions pivotally mounted on said mounting pin and straddling said contact arm, a crossbar secured to said bight portion of said drive arm and extending generally parallel to said mounting pin, and means yieldably connecting said contact arm and crossbar, the improvement comprising a handle arm assembly including a pair of spaced generally triangular side plate members straddling said frame portions and a fastening pin connecting first vertex portions of said side plate members, said side plate members being pivotally mounted adjacent second vertex portions thereof respectively on opposite end portions of said mounting pin, a generally T-shaped spring support member disposed adjacent the edges of said side plate members opposite said second vertex portions, the free end portion of the trunk portion of said T-shaped spring support member being curved partially around said fastening pin and the free end portions of the head portion of said T-shaped spring support member being bent respectively over said side plate members adjacent third vertex portions thereof, a tension spring operatively connected adjacent opposite ends respectively to said trunk portion of said T-shaped spring support member and to said toggle pin, a bushing carried by the lower end portions of said lower links, a rotatably adjustable pin having an eccentric cam portion disposed in said bushing and adapted to be rotatably adjusted with respect thereto, said adjustable pin being selectively mountable adjacent opposite ends in the leg portions of said drive arm in a plurality of different angular positions with respect thereto, said trip lever being releasable from said latched position to move the pivotal connections of said upper links thereto past the line of action of said spring and effect col-

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lapsing of said links and separation of said contacts, said inner shoulder portion of said operating handle having a curved outer surface generally complementary to said curved inner surface of said wall portion of said casing and having a recessed inner surface generally complementary to said handle arm assembly and spring support member, said wall portion of said casing holding said operating handle and handle arm assembly in assembled relationship for pivotal movement as a unit about said mounting pin, a resiliently flexible sealing member disposed between said wall portion of said casing and said inner shoulder portion of said handle, said sealing member having a hole through which said outer handle portion extends, said sealing member having a length sufficient to completely overlap said slot in all positions of said operating handle, said hole being sufficiently larger than said outer handle portion in the longitudinal direction of said slot to provide a lost-motion connection between said outer handle portion and said sealing member, a second terminal strap having an outer end portion electrically connected to said other terminal connector and having a relatively long inner portion extending generally parallel to the direction of the longest dimension of said casing along a bottom wall portion thereof, the length of said inner portion being such as to dispose an inner end portion thereof on the opposite side of said pivotal mounting of said contact arm from said other terminal connector, a bimetallic strip secured adjacent one end to said inner end portion of said inner portion of said second terminal strap, the other end portion of said bimetallic strip being free to move and being engageable with said trip bar to pivot it from said latching position upon sustained flow of moderate overload current through said bimetallic strip, a flexible conductor electrically connecting said bimetallic strip and said contact arm, a magnetizable core member recessed in said bottom wall portion of said casing beneath said inner portion of said second terminal strap, an armature rod mounted in said casing between said trip bar and said other terminal connector for axially reciprocal movement perpendicular to said bottom wall portion of said casing, and an armature mounted on said armature rod and biased away from said core member and attractable with said armature rod toward said core member upon flow of severe overload current through said second terminal strap, said inner portion of said second terminal strap having a hole there-through for reception of one end portion of said armature rod, and the other end portion of said armature rod having means engageable with said trip bar to pivot it from said latching position upon attraction of said armature toward said core member.

14. In an electric circuit breaker having an elongated generally rectangular casing, a pair of terminal connectors mounted on said casing respectively adjacent opposite ends thereof, a first terminal strap having an outer end portion electrically connected to one of said terminal connectors, a stationary contact secured to an inner end portion of said first terminal strap, a pair of spaced frame portions secured in said casing, a mounting pin supported by said frame portions, an elongated movable contact arm pivotally mounted adjacent one end on said mounting pin, a movable contact secured to said contact arm adjacent the other end thereof and movable thereby into and out of engagement with said stationary contact, a generally U-shaped releasably latchable trip lever having a pair of leg portions disposed between and pivotally mounted respectively on said frame portions, a generally U-shaped drive arm including a bight portion and a pair of spaced leg portions pivotally mounted on said mounting pin and straddling said contact arm, a crossbar secured to said bight portion of said drive arm and extending generally parallel to said mounting pin, means yieldably connecting said contact arm and crossbar, an operating handle extending outwardly of said casing and including a pair of side plate portions pivotally mounted re-

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spectively on said frame portions, a pair of upper links pivotally mounted adjacent their upper ends respectively on said leg portions of said trip lever, a pair of lower links, a toggle pin pivotally connecting the lower end portions of said upper links respectively to the upper end portions of said lower links, a tension spring operatively connected adjacent opposite ends respectively to said operating handle and said toggle pin, said trip lever being releasable from a latched position to move the pivotal connections of said upper links thereto past the line of action of said spring and effect collapsing of said links and separation of said contacts, and a trip bar pivotally mounted in said casing between the other of said terminal connectors and the pivotal mounting of said contact arm and pivotable from a latching position to effect release of said trip lever from said latched position and cause separation of said contacts, the improvement comprising a bushing carried by said lower links adjacent their lower ends, a rotatably adjustable pin having an eccentric cam portion disposed in said bushing for rotary movement with respect thereto, said adjustable pin being selectively mountable adjacent opposite ends in the leg portions of said drive arm in a plurality of different angular positions with respect thereto, a second terminal strap having an outer end portion electrically connected to said other terminal connector and having a relatively long inner portion extending generally parallel to the direction of the longest dimension of said casing along a bottom wall portion thereof, the length of said inner portion being such as to dispose an inner end portion thereof on the opposite side of said pivotal mounting of said contact arm from said other terminal connector, a bimetallic strip secured adjacent one end to said inner end portion of said inner portion of said second terminal strap, the other end por-

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tion of said bimetallic strip being free to move and being engageable with said trip bar to pivot it from said latching position upon sustained flow of moderate overload current through said bimetallic strip, a flexible conductor electrically connecting said bimetallic strip and said contact arm, a magnetizable core member recessed in said bottom wall portion of said casing beneath said inner portion of said second terminal strap, an armature rod mounted in said casing between said trip bar and said other terminal connector for axially reciprocal movement perpendicular to said bottom wall portion of said casing, and an armature mounted on said armature rod and biased away from said core member and attractable with said armature rod toward said core member upon flow of severe overload current through said second terminal strap, said inner portion of said second terminal strap having a hole therethrough for reception of one end portion of said armature rod, and the other end portion of said armature rod having means engageable with said trip bar to pivot it from said latching position upon attraction of said armature toward said core member.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,341,791

September 12, 1967

James H. Leonard

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 35, for "of" read -- or --; column 6, line 20, for "16" read -- 116 --; column 11, line 62, before "arm" insert -- drive --; column 13, lines 33 and 34, strike out "on said casing"; column 16, line 13, for "atractable" read -- attractable --.

Signed and sealed this 24th day of September 1968.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents